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SOME PERSONAL OBSERVATIONS.

By Surgeon H. R. CARTER.

JULY, 1902.

YELLOW FEVER INSTITUTE, BULLETIN No. 9.

Treasury Department, Public Health and Marine-Hospital Service.

WALTER WYMAN, Surgeon-General.

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Section C.—TRANSMISSION.

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In a paper read before the American Public Health Association at Buffalo, September 18, 1901, Dr. Doty, the quarantine officer of New York, affirms the absence of secondary cases of yellow fever aboard vessels—i. e., that while cases of this disease contracted ashore develop aboard vessels, yet none are contracted aboard the vessel itself—that is, the vessel does not become “infected” with yellow fever.

The experience of other quarantine officers has been different, and it may be of service then to group some cases already of record in which the contrary was observed. It is not proposed to collate a number of examples of vessels aboard which yellow fever was contracted, from the literature of the subject, but to give very briefly the history of some such vessels personally observed by the writer, from his own notes, during a four years' service (1888 to 1891, inclusive) at the quarantine of the Gulf, Chandeleur and Ship islands. Here were received all vessels believed to be infected with yellow fever bound for all of the Gulf ports, except for New Orleans and from Tampa south. Consequently our clientele was considerable. The bulk of them, however, although certainly the worst class of vessels which entered the Gulf of Mexico, were not, in my opinion, “infected” when I received them—i. e., yellow fever could not then have been contracted aboard them.

I will premise here that I accept without reservation the conveyance of yellow fever by an infected mosquito of a certain kind, and that to

me a vessel "infected" with yellow fever is simply one which is harboring these infected mosquitoes. Whether they came aboard already infected or, being aboard, became infected by feeding on cases of yellow fever developing aboard ship but contracted ashore, can in general be determined from the history of the spread of the infection. Indeed, it was primarily the history of these and other ships which led to the (tentative) formulating of the laws of the "interval between the infecting and secondary" cases of yellow fever and the "period of extrinsic incubation of places" of that disease, which, and much else, are so clearly explained by the conveyance by a mosquito host.

The deductions as to the disease being contracted aboard the vessels, when such deduction is made, are, however, independent of the assumption of any theory of conveyance. I do assume, however, that the period of incubation of yellow fever, rarely, if ever, exceeds six or six and one-half days.

1888.—SHIP ISLAND.

I. Norwegian bark *Magnolia*, 946 tons, fifty-six days from Rio de Janeiro via Pensacola Bar, rock ballast. Left Rio de Janeiro May 20; left 2 men sick in hospital and had 1 aboard, considered yellow fever. Master sick third day out, May 22; died, May 27. All well till June 1, then several (3) got sick at once. First mate sick, June 11; died, June 17; black vomit. All were sick on the way up except 2; 21 on crew list including the 2 men left in Rio de Janeiro. One of these who escaped fever had had yellow fever, and the other was a lad from Dantzic on his first deep-sea voyage. In all 17 men were sick of fever en route, of whom 5 died. The last case, Elias Eliassen, developed June 14. Here, save the captain, all sickened not less than eleven days after leaving Rio de Janeiro, and the first mate and Eliassen on the twenty-third and twenty-sixth day, respectively. They then contracted yellow fever aboard ship.

The picture is that of an infection introduced aboard the vessel by the men who sickened in Rio de Janeiro—i. e., there were uninfected *stegomyia* aboard which were infected from these cases and conveyed yellow fever to the remainder of the crew, except the captain, who contracted it ashore. I did not record the dates of the cases of the men left at Rio de Janeiro; it was shortly before clearing. The interval between an infecting and a secondary case is almost always fourteen days or over.

II. Italian bark *Riagino*, Rio de Janeiro, for Pensacola, fifty-one days out; rock ballast, 560 tons. No sickness in Rio de Janeiro until just before leaving, then sent 2 men to hospital. Left five days after. Log shows men were taken June 4 and June 6 and removed on June 6. Sailed on June 10. No one had been ashore save master and steward, using a harbor boat.

First case reported sick en route June 21; 1 next day; 6 sick en route;

3 deaths, June 28, June 29, and July 14, all with black vomit. Crew refused duty at second death. Last case well July 13. Sixteen on crew list; 2 in Rio de Janeiro. Master had had yellow fever; steward sick just after leaving, not considered yellow fever.

Six cases developed ten days after leaving Rio de Janeiro. Same remarks as were made of the *Magnolia* apply here.

No record is made of where these 2 vessels lay in Rio de Janeiro, the writer not then appreciating the importance of this.

1889.

My notes for 1889 are lost, and indeed there may have been in 1888 more than the 2 vessels given above, which should have been included in this paper; but my notes, taken at first solely with the view of determining the period of incubation of yellow fever, give data on only these two sufficiently definite to determine that they were infected—i. e., that yellow fever was contracted aboard.

1890.

III. British ship *Avon*, in rock ballast; 22 in crew, 4 immune to yellow fever. Sailed from Rio de Janeiro April 20. All well in port and en route until thirty-eight days out, when a boy in port watch sickened with yellow fever. Taken to hospital, Gulf Quarantine, on third day, and died on sixth day. Another case developed two weeks later in a quarantine attendant who helped me clean up the room, sail locker, in which the boy was sick aboard ship.

It is remarkable that there should have been only 1 case of yellow fever among the crew aboard this vessel. At the time it was ascribed to the fact that this boy, the only one on the port watch, helped a man, shipped in Rio de Janeiro and immune to yellow fever, overhaul his chest a few days before the boy was taken sick. Whether there was an infected mosquito in the chest which had survived this length of time, or whether there was any relation between the chest and the fever, may be a question. It in no wise affects the present question, that the disease was contracted aboard. It was the first case seen at this station that year.

IV. British ship *Curlew*, from Rio de Janeiro, with rock ballast. No sickness was reported en route, in port, or on arrival. She was cleaned July 22 to July 23, 1890, and disinfection completed July 25, in the afternoon. One case of yellow fever developed July 27, the sixty-fourth day out, in the early morning before day.

V. British ship *Chippewa*, from Rio de Janeiro, with rock ballast. No sickness was reported in port, en route, or on arrival. She was cleaned July 26 and July 27, and disinfection completed July 28. One man, the quartermaster, developed yellow fever July 29, at night, sixty-eight days out from Rio de Janeiro.

The *Avon* made no port after leaving Rio de Janeiro and communicated with no vessel en route. The other 2 made no port save Pensacola Bar, and communicated with no vessel save the pilot boats there and off Mobile Bar. The infection in these 3 vessels, then, must have been contracted aboard. They lay in open roadstead at my station, 1½ miles off shore and about ½ mile apart, and there was no visiting between them and none of their crews was ashore.

VI. Spanish bark *Castilla*, fifteen days from Cienfuegos via Round Island Quarantine, in rock and earth ballast; 14 in crew. Eight days out from Cienfuegos to Round Island. All well in port, en route, and on arrival. Mate sickened fourth day after arrival at Round Island while discharging ballast. Vessel sent here in tow August 22. Mate had yellow fever; died on the sixth day of illness. Captain developed yellow fever day after mate's death; taken to hospital. No other cases of sickness aboard; the remainder of the crew are, save 1, Manila men, and all probably immune to yellow fever, being mainly residents of Cuba for many years.

Here 2 men developed yellow fever, 1 twelve and 1 seventeen days after leaving Cienfuegos. The infecting mosquitoes may well have been harbored in the hold, which the mate would probably not have visited until he anchored at Round Island and began discharging ballast, and in which the master would not be apt to go while the mate was on duty.

VII. Spanish bark *Grand Canaries*, seven days out from Havana July 7. All well in port, en route, and on arrival and while in quarantine. Crew probably all immune to yellow fever, being mainly Manila men and old residents of Havana.

O. F., quarantine employe, went aboard as ballast master; next day developed yellow fever, July 11. This man had been exposed to no possible source of infection for the six months previous except this vessel. A case nearly similar to the above occurred in 1889, but I have no notes of it.

VIII. Norwegian bark *Queen of the Seas*, in rock ballast, Rio de Janeiro for Pensacola, fifty-four days out. Left Rio de Janeiro with 17 men; 6 deaths en route. All well in Rio de Janeiro. Lay at Mocanque, a healthful part of harbor. None save master allowed ashore, but he went in ship's boat. Left 1 man at Rio de Janeiro—consumption. Shipped 1 man, a negro, in his place. Sailed April 23; master sick April 26; second mate sick night of May 10; 2 men May 11; 1 man May 12; 2 men morning of 13th; 2 during day of 13th; 1 man sick and 1 died 15th; 1 man died 17th; 2 sick 17th; 1 died 19th; 2 died 21st and 22d; 1 sick 21st; 1 died 25th; 13 sick en route, 5 died. The man shipped in Rio de Janeiro (negro) and 1 of the others immune by previous attack. The picture is very clear of a clean ship, infected by the illness of the master contracted ashore—i. e., had uninfected mosquitoes aboard, which became infected from the master sick of yellow fever, and conveyed it to the crew.

1891.

IX. British ship *Curlew*, fifty-seven days from Rio de Janeiro for Pensacola. Lay in the Gamboa last eight days. Two men sick February 27, taken to hospital that day; sailed March 1. Master sick March 1; 5 men besides him that night. Two men March 4, 1 March 5, and 2 more during the day. Two men sick March 7. Two men died the 19th, sickening the 13th and 15th, respectively, both with black vomit. All aboard here, 19, were sick en route except 1, a Barbados negro; but don't believe all had yellow fever, the crew having been badly frightened. The earlier cases and the 3 who died were undoubtedly yellow fever, as were the steward and mate. Here we have 2 cases, at least, developing thirteen and fifteen days after leaving Rio de Janeiro.

X. Swedish ship *Condoren*, seventy-nine days out from Rio de Janeiro via Pernambuco for Mobile. Rock and earth ballast; 18 in crew. All well in port. Lay in Gamboa last five days. No shore leave allowed, but took ship's boat to go ashore. Sailed March 3; 3 men sick March 5; 16 men sick, all told, up to March 26, and 6 deaths. Last man got sick March 26, when she put into Pernambuco short-handed and sent 3 sick men to hospital. Two men sick March 20; 4 men sick March 18; 1 man sick March 26 (really night of 25th). At Pernambuco she lay eleven days and was disinfected by sulphur. Shipped 8 new men, 4, probably 5, of them immune to yellow fever. Developed no sickness on the rest of the way up. Here 4 men developed yellow fever fifteen days from Rio de Janeiro.

XI. German ship *Gustav and Oscar*, Rio de Janeiro for Pensacola. Lay at Cobras, a healthful place. One case yellow fever at Rio de Janeiro, March 22, sent to hospital March 24. No shore leave allowed. Sailed from Rio de Janeiro April 1; first case sickness April 7, 2 men; 3 next day; 1 next morning, and 2 during the day of the 9th. One death on the 10th, leaving 6 men sick. Captain sick on the 10th at night after supper. Last case on 14th. Two deaths on 11th; 1 on 12th. Crew list shows 21 men left Rio de Janeiro; 14 sick and 4 deaths en route. It is reasonably certain that 4 of the remaining crew were immune to yellow fever by previous attack.

XII. Norwegian bark *Crown Prince*, fifty-eight days out from Rio de Janeiro for Ship Island. Lay at Moncanque. No sickness aboard in Rio de Janeiro. No shore leave granted, and did not use ship's boat to go ashore. Sailed April 29. Master sick second day out (April 30). Next case May 16; 3 (2 aft and 1 forward) became sick. May 17, 2 sick in morning, 1 in the day. May 18, 3 men in forecastle sick. May 20, 2 sick, 1 death. May 21, 1 death, 1 sick. May 23, 2 deaths. May 24, 1 sick. May 28, 1 death last night. May 29, 1 sick this morning. May 30, 1 death. The 1 case on the 29th was the last case taken sick. There were 14 men aboard and every man had fever, 6 dying. She put into Barbados on June 10, disinfected and shipped (in quarantine) 4

new men, 1 probably unacclimated. No more sickness en route. All of these cases except the captain's were not less than sixteen days from Rio de Janiero before developing.

XIII. French ship *Emily Postel*, twelve days from Vera Cruz via Pensacola quarantine. Had "sickness" aboard just before leaving Vera Cruz, 1 man. Sailed from Vera Cruz July 28; no sickness since until crew went to discharge ballast, August 12. One man sick yellow fever August 15, 2 men the same, August 19, and 1 man August 20. Disinfection by sulphur was done on the appearance of the first case of yellow fever and no case occurred save the above. All were developed more than sixteen days after leaving Vera Cruz, hence from infection on board. The history points to infection (infected mosquitoes) in the hold.

The picture given by the *Curlew* and *Conderen* are those of disease conveyed by mosquitoes coming aboard already infected just before they sailed. The infection was not introduced by the men who first sickened, the interval between them and the next cases was too short. Observe that they lay in the Gamboa, directly in the lee of a town badly infected. The other two give the usual history of a clean place (town or vessel) infected by some one developing yellow fever, contracted elsewhere, in it.

XIV. Dr. G., assistant surgeon U. S. Marine-Hospital Service, developed yellow fever June 18 at the Gulf Quarantine Station, and died June 29. He was immediately from New York, where he had been on duty some months, and had been at the station but fourteen days when he was taken ill. There had been no case of yellow fever at the station that year. There were a number of vessels in quarantine, but the *Gustav and Oscar* (No. XI) was the only one I judged to be infected. On this vessel, as on the others, he had been with me inspecting, opening up drawers and boxes, and going into every compartment, etc., for the disinfection. I thought his infection was from this vessel. It was certainly from some vessel.

I think it will be granted from the above that the ability of a vessel to carry the infection of yellow fever is no myth. Here are 13 vessels which did so carry it collated from only three years' observation at a single station. Such vessels are indeed rarer, much rarer, now than they were before 1894, yet they still come. I saw 2 at Tortugas in 1894. Other cases are reported by Geddings and by Echemendia at the same place and at Port Tampa quarantine. Rosenau reports a case contracted aboard the steamship *Vigilancia*, from New York, plying between New York and Vera Cruz via Havana, in 1899. The steamship *Bodo*, last year (1900), from Bocas del Toro, for Mobile, developed 3 cases of yellow fever, seven, eight, and nine days out from Bocas del Toro. It would not be difficult, I think, to multiply instances of recent date, yet that they are rarer is without question. On the factors which have brought this about we can barely touch.

Obviously there are two methods by which vessels can become infected. (a) A case of yellow fever contracted elsewhere may develop aboard a vessel already harboring *stegomyia* mosquitoes which become contaminated from it. (b) The *stegomyia* mosquitoes may come aboard already contaminated. In the first case, there being nearly always over two weeks between the infecting and the first secondary cases of yellow fever, it results that, if the first case occurs after leaving port, vessels, even sailing vessels, from Cuba and the Caribbean Sea will generally reach quarantine and (if at a southern station) be disinfected—i. e., mosquitoes killed, before it is time for the secondary cases to develop, or, indeed, to be contracted. This agrees with all observation. In vessels infected in the second way, cases of yellow fever may occur after a very short or no interval from leaving port. The causes, then, which have lessened the number of infected vessels at United States ports, are—

1. The very great falling off of vessels from Rio de Janeiro and Santos since the establishment of the Brazilian Republic. This does away with the bulk of the "long-trip vessels" we used to have, which are the only ones developing secondary cases en route if infected by a case of yellow fever developing aboard. (Vide *a.*)

2. The replacing of sailing craft by steamships. That steamers convey yellow fever less frequently than sailing vessels has long been known. This is because they lie a much less time in an infected port, and the discipline of their crews is better; no shore leave means no man goes ashore. They also make quicker trips, and thus are not apt to develop secondary cases en route, even if yellow fever contracted elsewhere develops aboard and they have the *stegomyia* aboard. It is also to be noted that the worst parts of the harbors of Havana and Rio de Janeiro, above San Jose wharf and the Gamboa, have never been berths for steamships. Note, too, that the sailing vessels displaced are the foreign sailing vessels; the American schooner was less often infected than foreign vessels.

3. Especially since 1893, and to some extent before supervision had been kept by United States sanitary inspectors in the more dangerous yellow-fever ports over vessels bound for the United States, especially of passenger vessels. Certain anchorages have been recommended as safe, others have been forbidden; notably the Gamboa at Rio de Janeiro and certain wharves and parts of the harbor at Havana. Passengers who it is believed will develop infection aboard have been barred; shipment of new men in the infected port carefully supervised; vessels in which yellow fever has occurred in port are disinfected before leaving, and many other measures taken to have the vessel leave port clean, or as nearly clean as commercial considerations allow. In general, the vessel owners, especially of the regular lines, have given hearty cooperation in these measures, as well as in keeping the crew aboard and in confining the visits of such officers as must go ashore to daylight.

These restrictions, especially the last, have by no means been absolute for all classes of vessels, but are well observed, in Cuban and Mexican ports at least, by probably over five-sixths of the tonnage. The sanitary measures to avoid infection (3) and the proportionate substitution of foreign sailing vessels by steamships (2) are without doubt the main factors acting in cooperation in lessening the infection of ships. No one can read Burgess' list of infected vessels in Havana Harbor (Report, U. S. Marine-Hospital Service, 1896) without noting how great has been that decrease in recent years.

We have said that if a case of yellow fever develops aboard a vessel harboring the *stegomyia* mosquito (proper conditions of temperature being premised) that they may become contaminated by feeding on him and infect others. A vessel which has no *stegomyia* aboard is like "noninfectible territory" and will not communicate infection, even if cases of yellow fever develop aboard. I think it fair to say that vessels plying to and from southern ports of the United States will, during the summer season, generally have the *stegomyia* aboard, independently of its berth in tropical harbors, and may at times breed them in their water supply. This mosquito, however, seems to be rare north of Virginia Beach (its distribution has not been sufficiently investigated, however), and a vessel plying to and from a northern port of the United States would not harbor this mosquito unless it came aboard in the tropical port. Now how far this mosquito goes or is borne from shore has not, I think, been directly investigated, but we do know that the crews of vessels moored off from shore (say 200 or more fathoms) in that part of Havana harbor seaward from the line between the Sta. Catalina warehouses and the Machina wharf do not develop yellow fever (unless close to some vessel which is infected). This means that contaminated *stegomyia*, at least, do not go so far from shore. Lying then at the anchorages accounted safe in Havana harbor, where the passenger vessels for the United States lie, one would think that the probability of any *stegomyia* coming aboard would be small. At Vera Cruz the vessels must lie nearer shore (although to windward of it), and experience shows that the crews of vessels lying there are not entirely safe, as I believe them to be in Havana, although infection in the part of the harbor picked out as safe is decidedly rare. The anchorages in both harbors regarded as safe are well to the windward of the town all summer. A direct investigation of this matter—i. e., the presence of the *stegomyia* aboard vessels from northern ports in different parts of the harbor of Havana and other tropical harbors, should be made.

To sum up—

1. Vessels aboard which yellow fever had been contracted—i. e., vessels infected with yellow fever have not been rare, at least at southern quarantine stations.
2. Such vessels are much rarer since 1893, and are not very common now.

3. That the diminution of the number of infected vessels reaching United States ports is due mainly to the sanitary measures for avoiding exposure to infection in the foreign port, and to the substitution of steam for sailing vessels. To some degree the falling off of the vessels from Brazilian ports is also a factor.

4. That a case of yellow fever developing aboard a vessel plying between southern ports of the United States and the tropics will probably infect the vessel so that other cases can, if time be given, be contracted aboard her.

5. Such vessels, however, if short-trip vessels, not more than ten or twelve days en route after the occurrence of the case of yellow fever, will in general be disinfected at southern quarantine stations before any other cases have been contracted aboard, although harboring infected mosquitoes.

6. That a case of yellow fever so occurring aboard a vessel from a northern port of the United States would be able to infect her or not according to whether she had acquired the mosquitoes *stegomyia fas.* in the tropical port.

7. It is, in general, then necessary to disinfect all vessels running between southern ports of the United States and tropical ports if a case of yellow fever occurs aboard, no matter where it be contracted; while vessels running between northern ports and the tropics may, through precautions in tropical harbors, have no *stegomyia* aboard and are thus not infectable by cases of yellow fever occurring aboard.

8. Some vessels giving no history of yellow fever in port, en route, or on arrival—even when many days en route—are nevertheless infected and communicate the yellow fever to those who go aboard, vide Nos. IV, V, VI, VII. Note, also, the first case aboard the *Avon*, No. III, was thirty-eight days out from Rio de Janeiro. This is probably due to the infection (infected mosquitoes) in parts of the vessels unfrequented by the crew while en route, or to the crew being all immune to yellow fever.

